TRICK CYCLE

TRICK-CYCLE TURBINE Ltd.

Creators of the world's first 4-CYCLE TURBINE ENGINE!

NOTE: *TCT* IS A PROPRIETARY ENGINE DESIGN IN EARLY STAGE DEVELOPMENT. THEREFORE, CERTAIN DETAILS AND DRAWINGS CANNOT BE MADE PUBLIC AT THIS TIME. PLEASE HONOR THE COPYRIGHT AND DO NOT PUBLISH 2-1-2021 PATENTS PENDING

"TRICK" IS DEFINED AS:

"AN ARTFUL WAY OF GETTING A RESULT"

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TCT **IS A FULL 4 &/or 5 - CYCLE TURBINE ENGINE THAT COMBINES THE BEST ELEMENTS OF THE ELECTRIC, PISTON, ROTARY & TURBINE ENGINES CREATING THE ULTIMATE HYBRID POWER PLANT AND THE WORLDS MOST EFFICIENT ENGINE DESIGN!**

ELECTRIC PISTON ROTARY TURBINE

TESLA invented a turbine! On his death bed, the man that once dreamed of electric airplanes powered by wireless energy, stated that his most important invention was;

"MY TURBINE!"

As important of a physics epiphany as Tesla's Turbine was, it was not an engine. BUT, perhaps Tesla had tapped into the deep spiritual magic of the possibilities of what a self-powered turbine could bring to humanity.

KEY FEATURES ARE:

#1. *TCT* *ELIMINATES 100%*
RECIPROCATING AND/OR ELLIPTICAL AND/OR OSCILLATING MASS!

2. *TCT* has zero (o) valves (meaning separate valve like structure such as poppet, check or reed) and yet completes four (4) separate cycles like a valved four 4-cycle engine but with extreme efficiency with cycle overlap between exhaust and intake virtually to completely eliminated!

3. *TCT* is a true 4 &/or 5 - cycle engine yet generates twice the number of power cycles per revolution than a traditional 2-cycle engine! (note: *TCT* is not a fools gold internal gear reduction design. see below)

A 10 + TIMES MULTIPLICATION OF POWER DENSITY =
A TOTAL REVOLUTION IN VEHICLE TRANSPORTATION

VS EV OR HYDROGEN FUEL CELL

A. ABILITY TO PRODUCE CARS, TRUCKS & SUVs WITH FUEL EFFICIENCY MULTIPLICATION REDUCING ACTUAL TOTAL "WELL to WHEEL" EMISSIONS BY 60% USING CONVENTIONAL LIQUID FUELS, UP TO 85% USING NEW SYNTHETIC LIQUID FUELS & UP TO 97% USING HYDROGEN, OVER COMPARABLE EV EMISSIONS USING STANDARD ELECTRICAL SOURCES AS FUEL, and CUT ALL OTHER FORMS OF POLLUTION REGARDLESS OF THE FUEL SOURCE.,

INCLUDING:

1. CUTTING THE RETAIL PRICE TO HALF OR LESS OF CURRENT EV PRICES AND MAINTAINING A $8-12K COST ADVANTAGE OVER EVs IN THE FUTURE BEST CASE PROJECTIONS (Including TESLA INC's new "Tabless" battery cell breakthrough) (est. every $5K retail price reduction doubles the market. Price differential is greater when compared to Hydrogen Fuel Cell (HFC),

2. LOWER OPERATING COSTS: Based on the current total with taxes and fees average cost for electricity of $0.23 per kWh + 12% (about $.257) taxes & fees that works out to about $8.89 per 100 mi for the EV with an average ideal condition rating of about 34.6 kWh/100 mi, 41.5 kWh/100 mi when factoring in real world temperature effects which can sap up to 47% of the range and are not fully accounted for in factory ratings (HFC = 2.5 – 3X higher fuel cost without taxpayer subsidy). That works out to $10.65/100 mi real world average fuel cost. At current gas prices a comparable ***TCT*** powered vehicle would cost $2.20-2.50 per 100 mi including all taxes and fees on liquid fuel. That represents a **76 - 80% fuel cost savings.**

The greater the success of EVs, combined with the much higher cost of renewable power generation, the greater the likelihood the cost of electricity will rise (& reliability fall) while liquid fuel prices fall,

3. PROVIDING 100+ (one hundred) TIMES HIGHER LB/MI FUEL RANGE CAPABILITY (ie total tank and fuel weight of 190 lbs = 3000 ***TCT*** mile range AND gets lighter to empty, vs EV 12-1300 lb battery pack = 190 factory recommended charging protocol & temperature loss factored real world mile range and weighs the same dead),

4. **10X** MINIMUM FASTER REFUELING & UP TO **100X** DEPENDING ON CHARGING SYSTEM AVAILABLE (@ the fuel ranges listed above in #3),

5. 25-35% MORE CARGO and/or PEOPLE SPACE and/or LOAD CARRYING CAPACITY,

6. ACCESSIBLE POWER @ 4X+ THE EV (or HFC),

7. HIGH FUEL SOURCE FLEXIBILITY EITHER AUTOMATICALLY OR SELECTIVELY WITH THE PUSH OF A BUTTON, INCLUDING HYDROGEN WITH ABUNDANT EXCESS OF USABLE POWER @ ZERO (0) (EPA defined ZEV standard) TAILPIPE EMISSIONS (Hydrogen Fuel Cell (HFC) cannot provide this kind of critically important flexibility without an IC engine on board, which, if that IC engine itself could run more efficiently on hydrogen (ie 69% BTE) would make the cost, and other issues, of a fuel cell, illogical) INCLUDING NEW LOW EMISSION SYNTHETIC LIQUID FUELS & LOW COST, LOW QUALITY and/or LOW OCTANE LIQUID FUELS,

8. GOLDIE LOCKS NOISE LEVELS @ 30-80% LESS THAN CONVENTIONAL IC ENGINE (depending on preference and load levels) BUT HIGHER THAN NEAR SILENT EV,

9. REDUCTION IN ALL FORMS OF POLLUTION INCLUDING INITIAL MANUFACTURE OF ELECTRIC MOTORS AND BATTERY PACKS (See Report by the Union of Concerned Scientists which concluded that EVs produce far more emissions in manufacturing than conventional vehicles requiring up to 19,000 miles to net out zero (0), however, just on the simplicity, size and weight reduction alone ***TCT*** will reduce production emissions an additional 20+% putting the EV up to 23,000 miles in the hole on day one (1) before considering any change in operating efficiency. Over the expected life of an EV this adds to about 10% more total emissions contributed than a straight up kWh run usage calculation), LITHIUM & COBALT MINING POLLUTION, LAND, LANDSCAPE AND LAND DECOMMISSIONING, USED OIL, USED ANTIFREEZE, USED TRANS FLUID & RECYCLING INFRASTRUCTURE, ETC.,

10. LOWER MAINTENANCE COST WITH NO OIL CHANGES, LIQUID COOLING CHANGES and/or MAINTENANCE, ACCESSORY or BOOSTING PULLEYS, GEARS, BELTS, HOSES, LARGE MULTI-GEAR AUTOMATIC TRANSMISSIONS, OR, TUNING, Etc. AND, WITH ABILITY TO RUN FOR A MILLION MILES and/or FOR DECADES WITHOUT EVER NEEDING A SINGLE COSTLY COMPONENT SUCH AS A HUGE BATTERY PACK or TRANSMISSION REPLACED,

11. MUCH HIGHER CRASH and/or MAINTENANCE SAFETY WITH ABILITY TO SHIFT HUNDREDS OF lbs OF MATERIAL TO PURE SAFETY ENHANCEMENT and/or EQUIPMENT AND YET STILL CUT OVER 1100+ Lbs OF EFFICIENCY ROBBING WEIGHT, WITH, ZERO (**O**) CHANCE OF EVER BEING ELECTROCUTED TO DEATH WHILE WORKING ON, RECHARGING OR CONDUCTING EMERGENCY EXTRACTIONS FROM, EITHER ON DRY LAND, OR, TOTALLY SUBMERGED IN WATER, AND,

12. NO NEED FOR INVOLUNTARY TAXPAYER FUNDING TO COMPETE WITH ANY ESTABLISHED OR EMERGING MARKETS IN ANY OF THE RELATED INDUSTRIES, or, FOR THE GOVERNMENT and/or THE PRIVATE SECTOR TO FUND A MASSIVE NEW INFRASTRUCTURE TO FUEL ***TCT*****.**

B. A NEW BREED OF 20,000+ RPM RACE CARS WITH INCREDIBLE SOUND!

1. Sound is a major part of the experience & entertainment value of auto racing. The spectator can actually feel the power of the race car through sound which has been studied and found to be pleasant to the human psyche, especially, the V8 resonance. Further, the race car driver is constantly receiving instantaneous feedback concerning critical & changing conditions through the exhaust note.

The EV & HEV drive breaks that connection.

The former head of the most prestigious racing association in the world, the FIA sanctioning body for ***F1*, Bernie Ecclestane,** recently stated publicly that ***F1*** needs to go back to the naturally aspirated (NA) direct drive IC engines of several years ago because "sound is everything" and ***F1*** is essentially in the "entertainment business". He also pointed out the cost advantage.

2. Sound is actually not the major issue. As it stands now, and well into the foreseeable future, it is not possible to make a light weight quality handling EV race car that can reach speeds exceeding 200 MPH on a large oval or road race course or maintain that level of performance for more then about two (2) miles without needing recharging for 90 minutes, let alone go for 500 mi with a few 10 sec refueling stops let alone a 24 hr endurance race.

3. It would seem then that maybe Drag Racing would be the entry point for EVs with only a few seconds of straight line driving at a time with charging time between runs. Here again the physics just do not agree. Ford has developed a 1500 HP EV capable of ¼ mi times of 8.3 sec. But a comparable 1500 HP NA (meaning no where near max potential) IC powered car completes the same ¼ mi in 6.3 sec making the Cobra Jet 1400 32% slower.

Some may think that at least the EV drag car is more efficient, better for the environment and will eventually catch up, but, reality & science, again, do not concur.
As it stands right now the IC powered drag car consumes less then one gallon of refined Sunoco Race Fuel per run while the Cobra Jet 1400 consumes about 3.5-4 gallons of diesel fuel per run not counting the energy to keep the huge battery pack cool. That is approximately 4 times the fuel AND emissions. Further, to "catch up" it would take a "quantum leap" in the already highly developed battery technology to cut the deficit in half and if by some miracle it could catch up all the IC powered drag car would have to do is flip a supercharger on and the EV would be looking at fading taillights again.

Once the novelty and curiosity of what an EV race car is capable of wears off what is left is overweight, slow & whiny race cars that are less efficient and actually worse for the environment.

This one example illustrates how that without super low cost and efficiently produced electricity from the grid, EVs cannot compete with IC cars (even without ***TCT***) on just about any level except maybe less routine maintenance and less liquid pollution in the form of dirty used oil and coolant spillage where most is recycled.

THE BOTTOM LINE is that any attempt to force the racing industry to electrify will

effectively destroy it along with the 100s of thousands of fulfilling & innovation inducing jobs it supports!

C. EFFICIENT LIGHTWEIGHT & COMPACT DIRECT USE POWER GENERATION!

D. A NEW WORLD RECORD FOR THERMAL EFFICIENCY SCALABLE TO ACHIEVE A NEW STANDARD FOR SUPER EFFICIENT STATIONARY POWER GENERATION!

E. FLYING CARS WITH INSTANT START, INSTANT FULL POWER AND TAKEOFF AT A FRACTION OF THE NOISE OF A TRADITIONAL TURBINE JET ENGINE WITH RANGE 30+ TIMES ELECTRIC!

F. AND MUCH MORE!

QUESTION: How is it possible for any engine where combustion is a main part of its operating principle to be more **efficient** and **cleaner** than an **electric motor**?

1. First, energy must be transported to an electrical power plant where it can be converted to mechanical work which is then converted to AC electrical power which then has to be transmitted long distances to homes where it can then be converted to stored DC electrical power in the EV battery pack which then has to be transmitted to a DC electric motor where it is converted back to mechanical work, again. Each of these steps multiply loses until over 60+% thermal efficiency (combined cycle gas turbine CCGT) at the power plant is reduced to an effective EV thermal efficiency of about 42-45%. This is slightly higher then most IC engines today combined with the power companies ability to buy huge amounts of energy at a lower cost and their price regulation this can (but often does not) result in a slim fuel cost savings. However, if an end user IC engine could achieve CCGT like thermal efficiency then the equation completely flips, favoring ***TCT*** in the range of 70-80% on both fuel cost AND emissions before considering all the other ***TCT*** efficiency enhancing parameters.

CANNOT BEAT THE MARRIAGE OF FIRE AND A TURBINE: 

2. As it stands right now wind farms intermittently produce electricity @ 4X the cost of the CCGT and solar is even worse. Wind also reduces emissions 25% less then the CCGT over coal. Further, the CCGT takes up far less space and can be strategically located to increase efficiency and minimize environmental and landscape pollution. With a 300 yr worldwide consumption level retrievable gas supply in the US alone, all the energy needs at all times can be ramped up reliably in minutes. Despite these now well documented and demonstrated facts, some are making claims that renewable power sourcing will increase to 38% of the total electrical power produced in the US by 2050. ***TCT*** predicts that 38% renewable goal will not materialize by 2050 or 2070. The main reasons are cost, the now well demonstrated unreliability of wind & solar at the exact times of greatest need & because the public will begin, at some point, to sour on wind towers and solar panels as far as the eye can see. In other words, excessive landscape pollution (& a little noise pollution spread over vast areas) will become an issue at some point. The emergence of the ***TRICK-CYCLE TURBINE*** engine & new low emission synthetic fuels was

also not foreseeable in that prediction and should have an impact on these decisions between now and 2050. However, even if it were to happen that is 29 years from now and EVs will still be putting out 35-40% (60% againt synthetic fuels) more emissions at the same "well to wheel" comparison at an ever increased relative fuel cost than ***TCT*** with all the same other cost and utility deficits listed above.

TCT achieves a fuel efficiency multiplication while emitting a tiny fraction of normal IC engine emissions through a combination of multiple factors, including:

A. Thermal Efficiency (TE) @ 69%
B. Multiplication of power density,
C. Extremely low internal friction & stress (reduced 95-99%),
D. Extremely low idle speeds,
E. Complete elimination of oil contamination of combustion,
F. Very high stable lean burn operation (30+:1 air/fuel),
G. High Exhaust Gas Recirculation (EGR) capability,
H. 1-2º UNDERLAP of exhaust to intake cycles vs 50-75º OVERLAP in IC engines,
I. Avg. weight savings of 350-600 lbs over IC engine W/power-train,
J. No need for multi-gear transmissions, AND,
K. aerodynamic packaging advantages.

All of this will push emissions so low that little to no exhaust gas after treatment, such as, catalyst, would be necessary under normal driving conditions. This of course would mean even more cost, weight, space and aerodynamic disruption savings.

Fuel Efficiency:

A typical efficient mid-sized IC powered car getting **35 MPG** hwy might need only about 15 HP to maintain a hwy speed of about 65 MPH. The friction power within the engine including the oil pump, water pump, valve train, piston rings, Etc. (not counting alternator) can consume as high as 17 HP. That means that more than half of the fuel consumed is just to power the engine itself (at high speeds and loads the % of friction power to brake power drops). This indicates that a reduction of 95-99% of friction power could account for more than a doubling of fuel efficiency in this scenario to **75 MPG.** Adding the weight, power-train and aerodynamic improvements pushes the fuel efficiency over **80 MPG** without factoring the changes in BTE OR adding regenerative braking. BTE is a different measure and when factoring in an 80% improvement, fuel efficiency increases to an astounding **150+ MPG** hwy or about **123 MPG** avg. Add regenerative braking and the avg increases to **134 MPG!**

Therefore, even at 100% sourced renewable, that could be used to make low emission total Hydrogen. ***TCT*** will not only run on Hydrogen it will do so extremely efficiently, far more than a Hydrogen Fuel Cell (HFC) at a fraction of the cost, AND, preserve all the other listed advantages at close to the same level as when powered by gasoline, alcohol or ethanol, etc., AND, produce ZERO (0) tailpipe emissions (as defined by the EPA ZEV standard). This can be achieved because unlike a conventional IC engine ***TCT*** can easily be tuned to limit uncontaminated combustion temperatures below the Oxides of Nitrogen (Nox) 1300ºF threshold while still producing more power then most drivers could safely handle let alone need. Further ***TCT*** will always have the ability to switch back to other fuels automatically or

selectively as actual need will arise, AND, produce a fraction of current emissions when doing so. This is something the stand alone HFC will never be able to do.

A QUANTUM LEAP IN BATTERY TECH IMAGINED:

Many so-called industry & government experts are forcing a top down investment of $billions in taxpayer and private funds based on the belief that all the drawbacks of BEVs will be overcome over time with breakthrough advancements such as the ICE itself has seen since it became the prime mover in the early 20th century. However, the comparison and predictions are highly misguided & wrong. The electric motors & battery tech are already far more highly advanced going into the BEV market than the ICE was when it started moving everything a hundred years ago. Electric motors are now very simple and extremely efficient in the range of 95-99% BTE. Therefore, there is nil to nothing that can be gained there. It all comes down to the battery.

For purposes of an imaginary experiment we will define a battery "Quantum Leap" as the combination of the following:

1. A 50% reduction in weight & size,
2. a 50% increase in storage capacity, (which = 3X power density)
3. a 50% reduction in cost,
4. a 50% reduction in charging time,
5. all with the same or better safety & longevity, AND
6. a reduction in environmental impact such as from Lithium mining.

Given the relatively simple construction & function of a battery & the monumental research and investment in improving battery technology in recent decades it is not logical that anything approaching this kind of "leap" will ever transpire. However, it cannot be said that it is 100% impossible.

THE REALITY CHECK is however that this pretend quantum leap in real world terms would amount to increasing the mileage of an EV from 100 to 110 mi/41.5 kWh. In every measure except price this "leap" would amount to an incremental improvement against ***TCT*** and even on price the EV would still be far behind.

This means that this wild likely NEVER realizable dream battery leap = only 10% higher actual user efficiency (due to the battery weight savings) at the same time that a successful feasibility study of the *TCT* operating principle in the form of the *TOMAHAWK TX* indicates an actual real potential for Internal Combustion to actually leap 20-30X that amount. This monumental human history changing development will destroy the case for the BEV at absolutely every possible measure!

Further, it must noted that as the BEV gets more power dense it generates more waste heat which becomes harder to control adding cost and complexity and will generally result in making the vehicle less reliable and more dangerous to operate, service, recharge and/or store.

In stark contrast when an ICE becomes more power dense with higher BTE all these concerns go dramatically in the opposite direction.

QUESTION: A **1000%** increase in power density would make the ***TOMAHAWK TX*** the single most important discovery in engine design in over 100 years. It would be like finding a new source of cheap abundant energy, so, obviously, this is **absurd**. Please explain mathematically & scientifically how such a thing could even be possible?

1. INCREASED EFFECTIVE TORQUE ARM MOMENT:

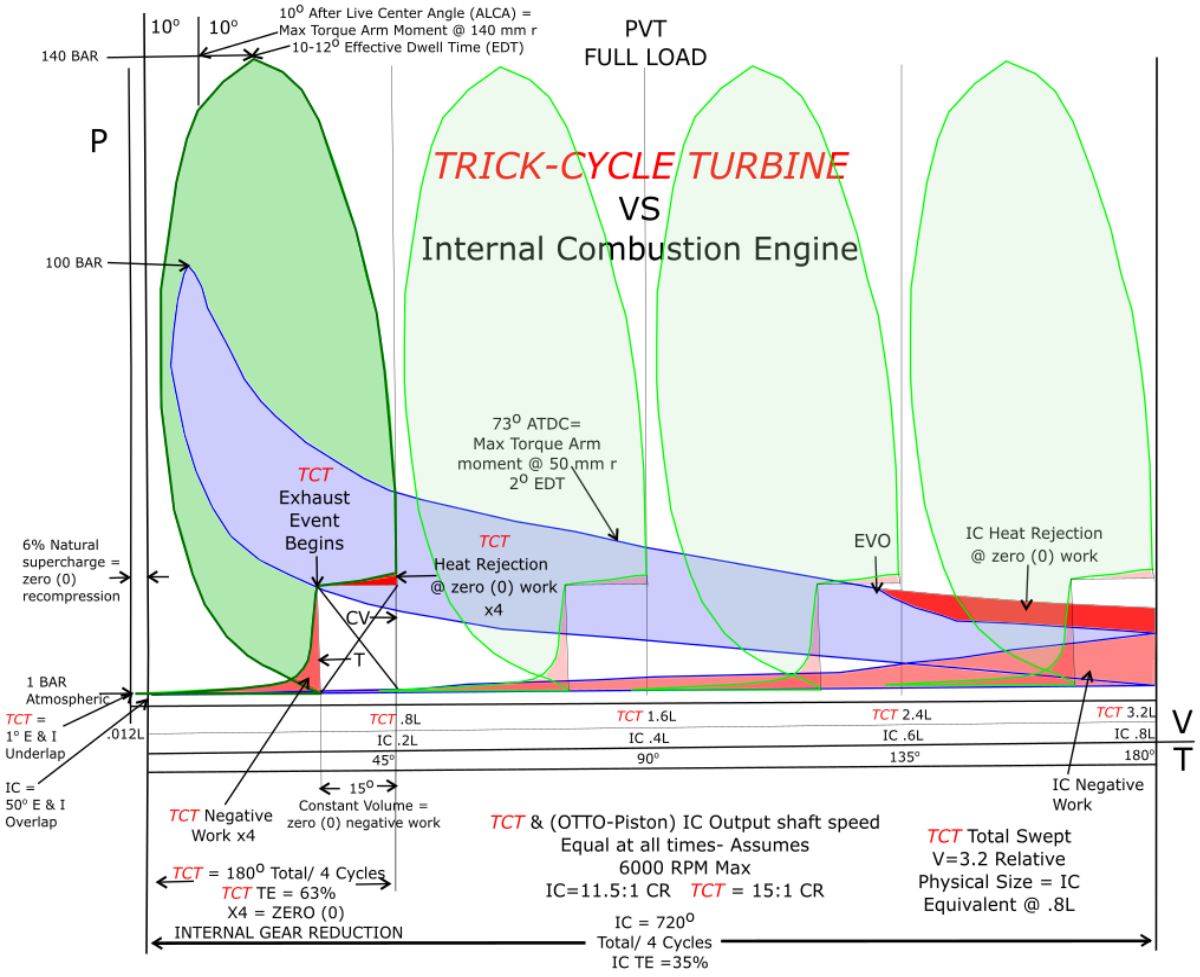
Mathematically calculating the increase in actual torque as measurable at the output shaft with a given increase in the torque arm length or radius (r) is rather simple, straightforward and reliable.

The formula is:

$$T = rF\sin(\theta)$$

Using perpendicular 90° as our default angle and everything else being equal including the total Force (F=PSI x area), dwell time, number of power pulses per revolution and mechanical loading & friction, an increase in the torque arm length, by itself, from the common IC 50 mm to the ***TCT*** 140 mm (As indicated in the Pressure/Volume/Time (PVT) comparison graph below) would increase the measured torque by 280%.

However, the PVT graph illustrates that the pressure (assume the dynamic area the pressure



acts on is equal) at the max torque arm moment is not even close to being the same. The IC = approx 33 bar (480 PSI) while ***TCT*** = approx 130 bar (1880 PSI). When that one (1) variable is plugged into our simple formula the overall measured torque increase = 1100%. Assuming both engines can operate at the same speed this would translate to an **1100**% increase in power density.

2. INTEGRATED DISPLACEMENT MULTIPLICATION (IDM):

Increased usable power density is the Holy Grail of engine design. This fact has led to many approaches and attempts to find a better operating principle for an engine. These efforts fall into four (4) main categories:

A. CHARGE BOOSTING, ie SUPER or TURBO CHARGING:

Result: Increased usable power density up to 70%.
Pros: Can be used to increase both power density & fuel efficiency & lower emissions.
Cons: Adds weight, size, noise, maintenance & complication & increases the actual apples to apples cost of a car between $500-2500.

B. WANKLE (ROTARY) TYPE CYCLING:

Result: Increased power density up to 80% but not usable in highly emission regulated environment.
Pros: Simple, low cost, replaces reciprocating mass with elliptical mass reducing internal friction and stress allowing for higher sustained RPMs.
Cons: Low thermal efficiency due to slower cycling time which increases heat rejection. Uneven heat distribution which warps motor making sealing unreliable. Requires the injection of oil into the induction tract which contaminates combustion and increases harmful foul emissions.

C. COMPRESSED CYCLING, ie 2-CYCLE:

Result: Increased power density up to 60%, largely unusable in a high regulatory environment.
Pros: Simplicity, less cost, size and weight than conventional 4-cycle engines by 20-30%.
Cons: Compresses cycles very inefficiently with substantial cycle overlap, uses crankcase as air and fuel pump requiring oil to be mixed with fuel which greatly increases foul emissions. Efforts to compensate for these issues are not fully successful and either absorb much of the cost advantage OR require lower speed operation eliminating the power density advantage OR both.

NOTE: The 2-cycle operating principle is a form of IDM where the total swept volume per revolution relative to the 4-cycle is more than the reference displacement volume, ie 100 cc reference size has an absolute sweep out of 160 cc effective displacement (discounting for overlap pumping losses) over the same 720° crank rotation. Based on this fact alone higher power density is reliably predicable.

In the 90s there was a major industry push to resolve the 2-cycle issues to make them compatible for use in the highly regulated mass vehicle production market. The lure again was increased power density combined with simplicity and lower cost. While some progress was made using

the Ralph Sarich (Founder of Orbital Engine out of Australia) fuel injection method, it was eventually determined that the 4-cycle type poppet valve system would have to be employed to have any chance of meeting emissions which absorbed much, if not all, the cost advantage. More importantly it cut the engine speed range in half which absorbed the power density advantage and then some.

While very likely motivated by proper intentions and very important and laudable aspirations, in the end, it ended up being a bit of fool's gold.

D. INTEGRATED GEAR REDUCTION:

Result: Failure, NO usable increase in power density.

NOTE: By simply applying a 4:1 gear reduction to any engine one could then claim that they have increased the number of power cycles per revolution of the final output shaft by 4 times and technically that would be correct. However, a gear reduction can only shift power (ie work) to increase low speed torque and even that is not @ 100%.

Some engine designers have essentially integrated a gear reduction function internally and made it part of the engines operating principle. Anytime reciprocating, elliptical or osculating mass is involved this method will almost assuredly end in failure.

One of the best examples of this is the radial 48 piston "Split Cycle" engine invented by Rick Mayne in the late eighties. Mayne attempted to mitigate the reciprocating mass stress by making the bore and stroke of the pistons very small and splitting their function. The result was 48 pistons connected radially to a Geneva Wheel.

It was fairly clear on paper that this design was likely to have issues. Nonetheless, the mere hint of a possible increase in usable power density was enough to for Mayne, without strong connections to the industry, to raise many $millions and create a company worth $200M in 1993 dollars without proof of concept or a full size working prototype. Once a prototype was built it began to fly apart at about 1500 RPM. This proved the limitations of reciprocating mass in such a context which dashed the dreams of achieving usable increased power density.

Again, while very likely motivated by proper intentions and very important and laudable aspirations, in the end, it ended up being a bit of fool's gold and all the investors lost their money.

BY CONTRAST,

TCT represents the discovery of an operating principle and method that uses IDM in the proper way. Besides having ZERO (0) reciprocating, elliptical or oscillating mass to hold it back, ***TCT*** does not employ ANY form of integrated gear reduction. YET, ***TCT*** does effectively multiply the displacement volume relative to a 4-cycle IC engine by 4X as illustrated in the "PVT" graphs above & below. This means that a 100 cid reference size engine (and physical size) would in actuality sweep out a total displacement volume of 400 cid WITHOUT some kind of self-canceling slight of hand.

ALL of the challenges of increased flow capacity, ignition speed and timing, Etc. to actually take full advantage of the extraordinary IDM capability of the ***TCT*** operating principle have been thoroughly investigated and studied. Incredibly, the unique operating principle of ***TCT*** itself inherently combines a clear and calculable ability to solve these type of would be challenges somewhat automatically, AND, amazingly, with room to spare. Therefore, in the context of

***TCT*,** IDM alone would account for around a 400% increase in usable power density.

3. IDEAL ENERGY CONVERSION DYNAMICS (ECD):

Energy Conversion Dynamics (ECD) looks narrowly at the time, place and manner that energy released from the combustion (chemical reaction) of fuel is then converted directly to mechanical work rather than just the size of the combustion event itself. ECD is the main factor in determining Brake Thermal Efficiency (BTE).

ECD FACTOR A:

Both the 2-cycle and the Wankle Rotary type engines indicate that increasing power density is not automatically corollary with increased BTE, in fact, they can actually go in opposite directions, depending on the ECD.

The Wankle Pressure/Volume/Time (PVT) graph below provides a clue. When compared with the IC piston engine PVT above it is clear that the Wankle cycles 50% slower. This extra time allows for more heat rejection which creates a host of issues. First, it limits the streetable Compression Ratio (CR) to about 9.5:1 max. This fact alone assures it cannot compete with the IC piston on BTE. The Wankle is generously listed @ 28% BTE and the IC piston is generously listed @ 35% BTE. Major efforts at great cost over decades could not overcome this inherent design flaw which forced the Wankle Rotary from mass production in 2016.

This comparison helps to illustrate how important ECD in the area of the speed of the energy conversion. Basically, everything else being equal, the faster the conversion can take place the higher the BTE is likely to be because there is simply less time for the energy in the form of heat to be rejected into the surrounding structure. Looking at both of the PVT graphs it is clear that ***TCT*** represents a significant improvement in this one area of ECD analysis alone.

This factor is also why new engine concepts such as the “LIQUID PISTON” & “OMEGA ONE” are very unlikely to achieve success in real world application because both inherently exhibit extremely poor Energy Conversion Dynamics which wipe out the potential from other intriguing advantages these designs include over existing production ICEs.

ECD FACTOR B:

Another area of ECD is the matching of the peak force generated to the maximum torque arm moment. AGAIN, simply looking at the PVT graphs it is clear that ***TCT*** represents a substantial improvement in this additional area of ECD analysis.

ECD FACTOR C:

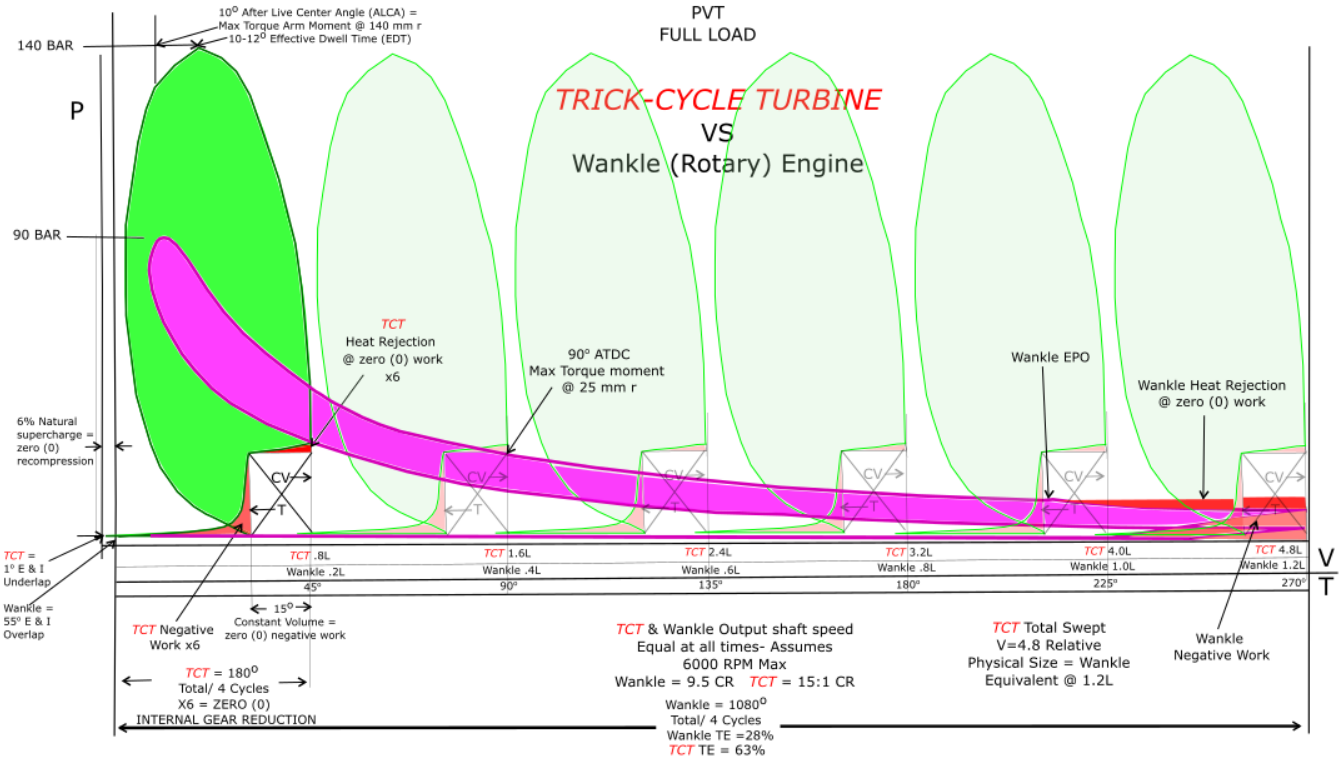
Still another area of ECD is the ratio of positive work to negative work & heat rejection @ zero (0) work combined. Looking at the PVT graphs it is obvious that ***TCT*** improves this key ratio exponentially, in fact it is seven (7) times higher when measured against the IC piston and six (6) times higher against the Wankle rotary. Since the PVT graphs do not assume the Integrated Exhaust Assist (IEA) (See below) is activated this factor alone represents an additional 14% increase in power density over the IC Piston and 11% over the Wankle rotary.

ECD FACTOR D:

Dynamic to static surface area ratio of about 2.5:1. For comparison the Achades Apposed Piston Diesel Engine has a D/S ratio of about .29:1, a typical IC piston engine is about .22:1.

*It is noteworthy that this major move towards ideal ECD that **TCT** represents will allow for the use of low cost, low quality and/or low Octane fuels. This would give **TCT** very high utility value in places like India or Brazil and anywhere in the world where developing an extensive EV infrastructure is both cost and practicality prohibitive. Yet further, it allows for much lower peak combustion temperatures to a level that can effectively eliminate the*

production of Oxides of Nitrogen (NOx) when using most any fuel, including, Hydrogen.



4. INTEGRATED CHARGE BOOST (ICB):

TCT incorporates in its operating principle a "NATURAL SUPERCHARGE" of about 6% as indicated on the PVT graphs. ***TCT*** additionally includes in its basic design the ability to self boost without adding any mass, dynamic or otherwise, or adding any gears, pulleys, belts or chains. As such it is the most efficient form of boosting possible. Again it is possible to

mathematically calculate the amount of atmosphere displaced by the boosting system vs the amount of atmosphere the engine can displace naturally (thus the term naturally aspirated) and make an accurate calculation within a range. Based on this calculation ***TCT***'s integrated boosting when fully engaged will multiply the power density as discussed above in the range of 70-110%.

5. INTEGRATED EXHAUST ASSIST (IEA):

TCT incorporates in its basic design the ability to power assist the scavenging of exhaust gases again without adding any mass, dynamic or otherwise, or adding any gears, pulleys, belts or chains. It is in effect a reverse turbo charger. The system is on the fly instantly tunable to maximize performance whenever desired. It is projected that this system will conservatively increase power density an additional 8-12%.

NOTE: This same system doubles as an on the fly tunable noise control mechanism eliminating the cost, weight, space AND aerodynamic disruption of conventional noise suppression systems.

6. SPEED DENSITY:

The power density case so far has all been based on an equal max speed analysis @ 6000 RPM. This speed was chosen because it is familiar in the automotive industry and most popular V8 engines are rev limited to approximately that max speed. This is necessary because a slight over rev of these engines have the potential to lead to instant catastrophic failure due to enormous stress created by their reciprocating internal mass.

From a pure mechanical perspective there is no reason a ***TRICK–CYCLE TURBINE*** could not rev to 50,000 RPM, sustained. Any limits on achieving that kind of usable speed would be based on other factors none of which create a risk of instant catastrophic failure. Power density is directly linked to speed, everything else being equal.

The formula is:

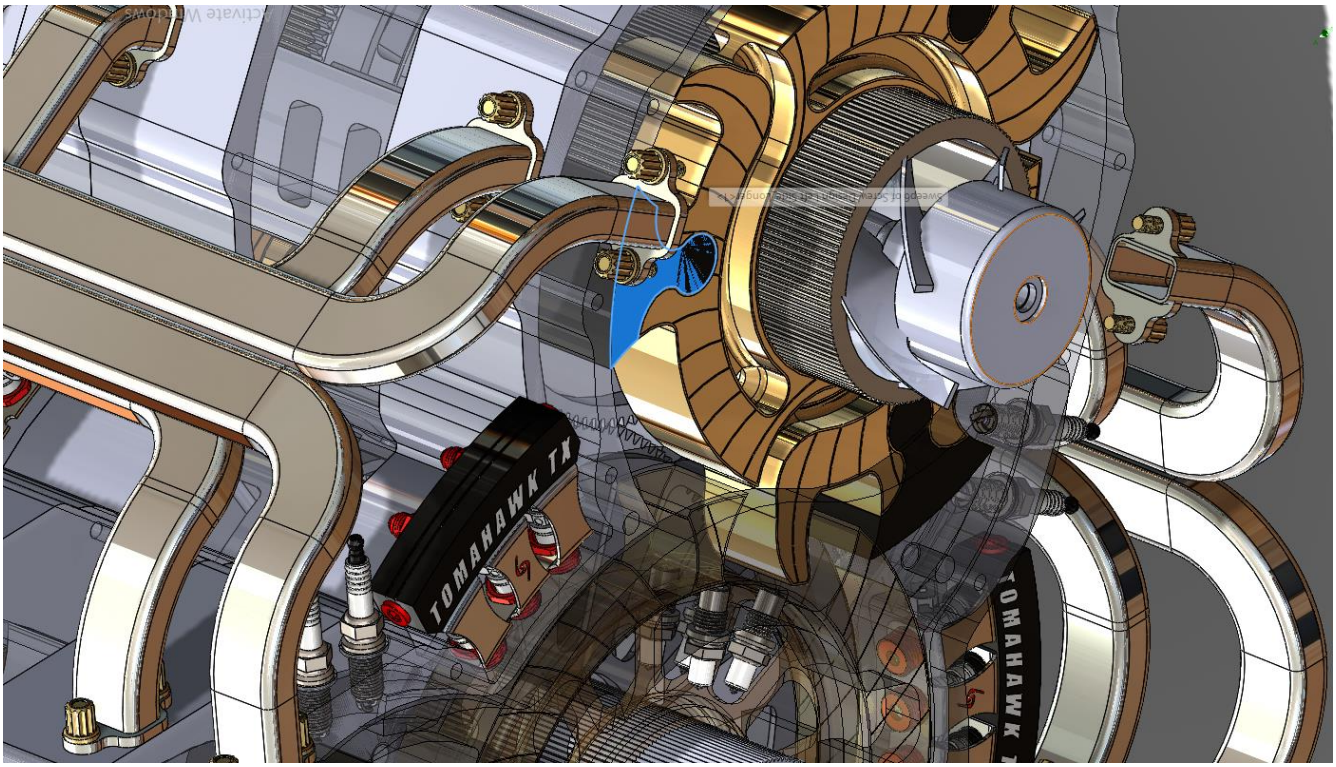
$$\mathbf{HP = \frac{T\ (ft/lb)\ S\ (RPM)}{5252}}$$

So, maintain the same torque @ double the speed and the actual measurable power density, doubles. This means that whatever the actual multiplication of power density ***TCT*** is capable of @ 6000 RPM, it doubles @ 12,000 RPM and triples @ 18,000 RPM. One area of potential challenge for these high speeds is combustion stability. For some frame of reference on this subject, for years Formula **1** (***F1***) Racing successfully campaigned naturally aspirated reciprocating piston engines that made full stable power @ 21,000 RPM with one (1) spark plug per cyl.

SOURCES FOR TECHNICAL ANALYSIS HEREIN ARE NOT LIMITED TO AND INCLUDE:

Deloitte Insights, "Electric Vehicles - Setting a course for 2030" (July 28, 2020), *EVO,* "Synthetic fuelled cars as clean as electric cars, says Porsche" (February 17, 2021) *The Springer link* - "Reducing Vehicle Weight and Improving U.S. Energy Efficiency Using Integrated Computational Materials Engineering" (August 12, 2012), *US Energy Information Association* (EIA), *EPA, DOE, DOD, UCS, Wikipedia and others*

A GLIMPSE INTO THE FUTURE



CONSIDER THE SOURCE

If you are blown away by what you have just read, you should be. If you were not, you should "CONSIDER THE SOURCE".

CREDIBILITY OF THE INVENTOR:

TRICK-CYCLE TURBINE inventor **Reggie D. Huff** started his first research company in 1992 called Acro-Tech. In its first year it became one of 14 research companies (out of 203 applicants 65% of which the lead investigator was PHD credentialed) to receive a feasibility research contract from the EPA administered through the University of Pittsburgh and the Centers for Hazardous Materials Research (CHMR) headed by Dr. Berkey. Dr. Berkey and his staff told Mr. Huff directly that his proposal was considered the best of the lot that year. Included below is a copy of an Acro-Tech brochure that includes an article published in MOTORTREND Magazine which was one of several articles published on Mr. Huff's work in top publications of the day, including, Popular Science. The data graphs included in the MOTORTREND article is that which was certified by Dr. Micheal Seal the head of the Vehicle Research Institute in 1994 and comes from tests conducted by himself in the VRI laboratory after he openly predicted the Vented Valve System "will NOT work".

Mr. Huff has what may be an unprecedented track record on engine design, all of which, as it has turned out, was just a precursor to and preparation for, the most monumental discovery in engine design since the invention of the engine itself.

Mr. Huff has developed an ability to find the most elegant & simple solutions to complex engine design challenges, including but limited to:

#1. **The Vented Valve - US 4,901,683 issued 02/20.1990 + US 5,357,914 issued 10/25/1994 + US 6,237,549 issued 05/29/2001**
(See: MOTORTREND article below)

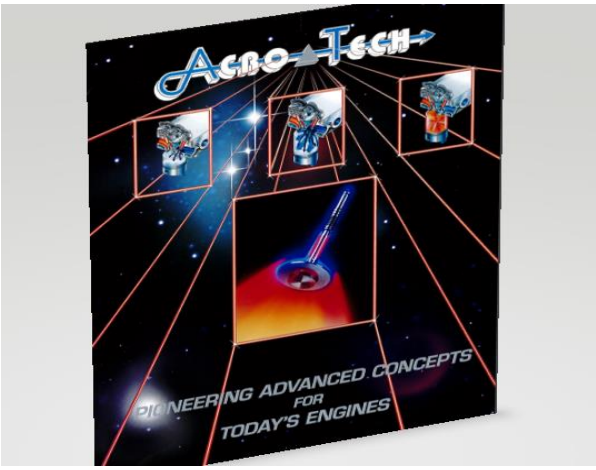
#2. **The Smart Valve - US 6,659,059 issued 12/09/2003** (independent data available)

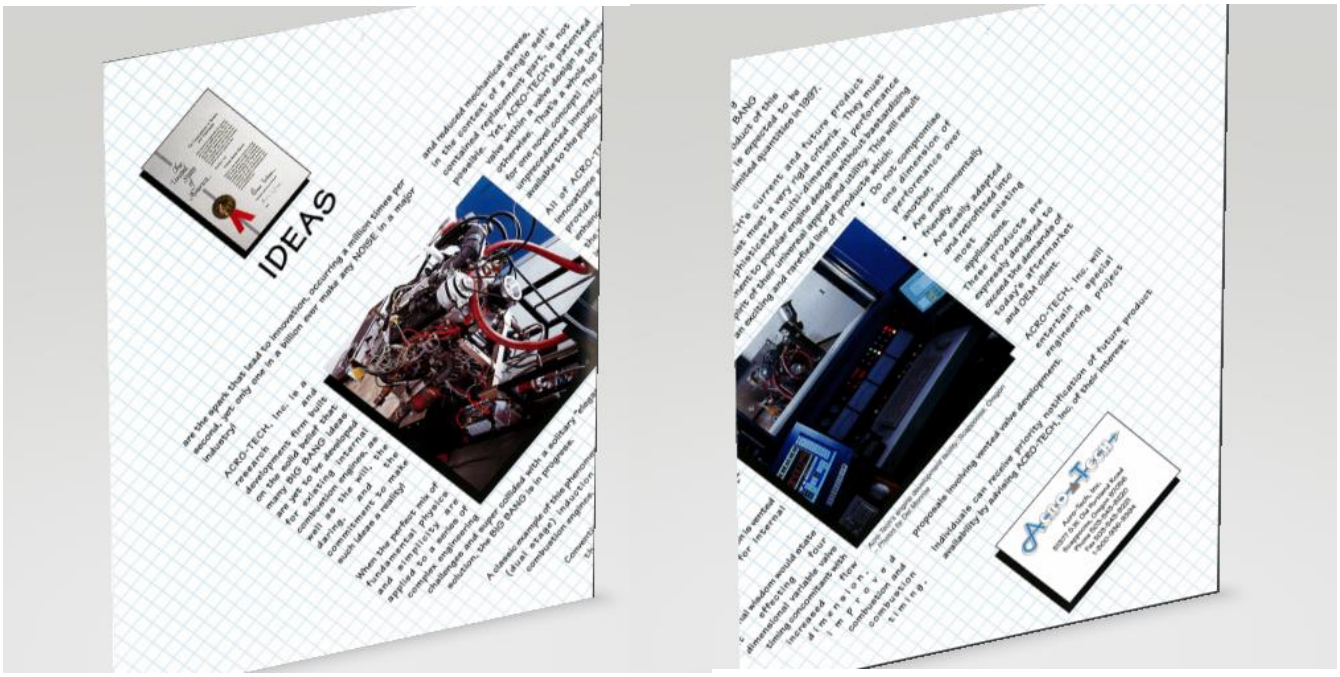
#3. **Hybrid Fuel Injection - US 10,920,726 to Issue on 02/16/2021** (See: **dynoblade.com** for copious independent data) Currently assigned by way of exclusive license to: **XCENTRICK INNOVATIONS Ltd.**

In each case Mr. Huff made predictions concerning the levels of gains in both power & efficiency that could be expected PRIOR to building the first prototype. In each and every case once the first prototypes were made and independently tested the pre-prototype predictions were validated to be on target OR conservative despite the fact that first prototypes never represent close to the maximum potential.

This experience has the power to so completely extract an innovative mind out from the "box" as to make it prime for an epiphany of discovery.

Under normal circumstances it might make sense to bet against what appears at first glance to be outlandish claims, but, here, in this context, it might not!





Mr. Huff has also successfully prosecuted seven (7) patents to issue grant and has never lost a single patent case. He has also hired out his expertise as an IP consultant. Mr. Huff has conducted a review of prior art and determined that the odds that any critical part of ***TCT*** would not be patentable is extremely low but the possibility that all of the critical aspects would not be patentable would be close to non-existent. The initial funding will be used to generate a patent application portfolio approaching twelve (12) applications deep and world wide (in all key strategic markets). This is an application portfolio that will increase the value of ***TCT*** exponentially leading to a patent portfolio that will increase value, exponentially, again.

Contact: **Reggie D. Huff** directly **@ 330-373-8106 OR rhuff@tomahawkturbine.com**

tomahawkturbine.com

TESLA: "When I get an idea, I start at once building it up in my imagination, I change the construction, make improvements and operate the device in my mind. It is absolutely immaterial to me whether I run my turbine in thought or test it in my shop. I even note if it is out of balance. There is no difference whatever; the results are the same."

"MY TURBINE!"